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DEVELOPMENT OF A DECISION ROOM FOR ENVIRONMENTAL STUDIES (FEASIBILITY STUDY)

John G. Moore

Datametric Corporation

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~~A study of~~ existing "Decision Room" facilities were studied ~~was made~~ to determine the initial feasibility of constructing a "Decision Room" facility for development and use of environmental simulations. Through presentation of the simulations, public officials would be apprised of environmental measurements and could view the simulated consequences of decision making and legislative policy inputs.

The study concluded that "Decision Room" technology is feasibile and recommends a "Research and Analysis Facility" oriented to the development of a prototype facility and its supporting capabilities as an appropriate first step for EPA. The architectual renderings of such a facility are presented. The study indicates that recent developments in computer based technologies have so improved information processing, storage, retrieval, and presentation that EPA requirements involving large amounts of complex information handling in these areas can be met. (EPA)

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EPA REVIEW NOTICE

This report has been reviewed by the Office of Research and Development, EPA, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

ABSTRACT

The Datametric Corporation received a grant to develop a "Decision Room" facility which would accommodate the development of environmental simulations wherein public officials would be made aware of measurements of the environment and the consequences of legislative and executive policies. The facility would house the research activities associated with building and refining mathematical models which simulate the ecological, social, economic and institutional systems that guide urban and regional growth. The grant has four phases:

- o Feasibility Study
- o Development of Design Specifications
- o Construction of "Decision Room" Prototype
- o Research and Evaluation of Prototype

This report relates to the work authorized under Phase 1, Feasibility Study. To assess the feasibility of the "Decision Room", a survey of related facilities was conducted to benefit from the experience gained in their development. The survey included computer graphic related technologies and supporting data management systems to determine their effect upon the feasibility of the proposed facility. The data from the surveys were analyzed with the result being the development of architectural renderings for a prototype facility.

The study revealed that such a facility is feasible and recommends the construction of a "Research and Analysis Facility" (prototype), as a first step, which can be incrementally equipped and expanded. This approach assures that experience is gained in operation of the system components and data management services which would support a "Decision Room" operation.

The report presents architectural renderings of the Research and Analysis Facility. The study indicates that computer based technologies have so improved the retrieval, processing and presentation of information that much of the previously necessary 'red-tape' and costs of data processing can be avoided altogether. The construction of such a facility would be an important step in enabling the Environmental Protection Agency to use effectively the large amounts of information involved.

This report is submitted by The Datametric Corporation under the sponsorship of Environmental Studies Division, Office of Research and Monitoring, Environmental Protection Agency in fulfillment of authorized work on Project No. R801522, Grant No. 87A076. Work was completed in June 1973.

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HUD	Mr. Donald Valentine	General Program Evaluator
DSMS	Major David Whatley	Administrative Officer
AVON	Mr. William Kiernan	Manager-District Sales

One of the highlights of the study was the conceptual renderings of the facility and accompanying design work produced by the architectural subcontractor, Arthur Cotton Moore, and his designer, David Cox. These renderings make it possible to visualize the facility and they stimulate the imagination regarding its use.

The contractor for the study was the Datametric Corporation. John Moore, Vice President, brought experience in data communications systems, facility layout, cost-benefit analysis and statistical surveying to focus on the primary work of this phase of the DECISION ROOM FACILITY project.

The project would not have been possible without the sustained guidance and cooperation of Director, Peter House; Al Pines; Alan Neuschatz and Martin Brossman of the Environmental Studies Division, Office of Research and Monitoring, Environmental Protection Agency.

SECTION I

CONCLUSIONS

The amount of information required to support environment protection functions and the related coordination of government agencies is increasing dynamically together with the scope and complexity of environmental problems.

One of the major problems to be faced by the Environmental Protection Agency and the Environmental Studies Division is the problem of performing environmental threat assessment.

The complex factors inherent to the environmental threat assessment problem present a unique problem set. This problem is compounded by the Environmental Protection Agency's dependency on other agencies for information inputs.

Decision makers are unwilling to make the hard economic, sociological and political decisions regarding pollution countermeasures on the bases of imprecise or unevaluated data.

The existing research and development facilities of the Environmental Protection Agency are inadequate to develop computer based methodologies and procedures to support the environmental analyst.

None of the "decision room" facilities and supporting information processing systems surveyed to date are capable of handling the scope and complexities of the environmental threat assessment problem set. System components, information processing methodologies, and display facilities must be selected and integrated into the system design to provide the capabilities that will meet the Environmental Protection Agency's requirements.

The "decision room" concept is a feasible one. The technology to develop a "decision room" and the supporting information processing systems is within the state-of-the-art and the human factors data are available to "tailor" the supporting man/machine interfaces.

It appears the title "Decision Room" is inadequate to describe the required facility. A more descriptive title reflecting the scope and complexity of the facility and supporting systems would be "Environmental Research and Analysis Facility."

SECTION II

RECOMMENDATIONS

Based on the conclusions of this study, continue the project to design and build a Research and Analysis (Decision Room) Facility to support the Environmental Studies Division of the Environmental Protection Agency. The facility will be used for experimentation in environmental research and for dissemination of information to state and local governments through the agency's network of Regional Studies Centers. The project will be continued, as planned, in the remaining three phases:

- Development of Design Specifications
- Construction of the Research and Analysis Facility Prototype
- Research and Evaluation of the Prototype

Using the Environmental Studies Division's existing facilities, equipment and methodologies as a functional and technical baseline, initiate development of the design specifications for a prototype Research and Analysis Facility and the supporting information management system. It is further recommended that the following tasks be addressed in sequence:

- Determine the system functional requirements through analysis of available data.
- Develop a functional system design.
- Finalize the space arrangements for housing the prototype system.
- Select the man/machine interface devices.

Upon approval of the findings and recommendations of this study by the Environmental Studies Division and the Environmental Protection Agency, it is recommended that The Datametric Corporation prepare and implement a detailed work plan for development of the design specifications for the prototype system.

SECTION III

TECHNICAL DISCUSSION

A. INTRODUCTION

This report covers the first phase of a four-phase grant received by the Datametric Corporation under the sponsorship of the Environmental Studies Division (ESD), Office of Research and Monitoring, Environmental Protection Agency (EPA). The objective of the resultant project was to design and build a "Decision Room" facility to support the Environmental Studies Division of the Environmental Protection Agency. The facility, envisioned as an extension of the National Environmental Studies Center, will be used for experimentation in environmental research and for dissemination of information to state and local governments through the agency's network of Regional Studies Centers. The approach was to develop a prototype to validate the decision room concept. To validate these concepts, the grant and resultant project were divided into the following phases:

- o Feasibility Study
- o Development of Design Specifications
- o Construction of Facility Prototype
- o Research and Evaluation of Prototype.

1. Study Objectives

The overall objectives of this phase (Feasibility Study) of the project was to determine the feasibility of constructing "A Decision Room Facility for Environmental Studies" by studying related facilities, equipment and technology as applied to ESD objectives. The specific tasks to be accomplished during the feasibility study phase was:

- o Identify and select situation rooms for detailed study
- o Identify the objectives of situation rooms currently in operation
- o Describe the physical characteristics of each situation room
- o Describe the man/machine interface technologies employed
- o Evaluate their effectiveness based on statement of objective
- o Develop Decision Room renderings
- o Describe man/machine interface devices
- o Estimate Decision Room prototype construction costs.

2. Scope

While accomplishing the tasks listed above, surveys were made of existing related facilities, equipment and technologies. The surveys were analyzed in light of ESD objectives, conclusions were drawn and a concept design of a facility was developed to meet these objectives. The design concept was presented to the architect for development of conceptual renderings of the facility to meet the ESD requirements. Recommendations were made concerning the next phase of the project. An overview of the scope of this study is presented in Figure 1 . From the number of facilities that currently support decision-making, a representative group was selected which most nearly approximated those capabilities most applicable to EPA operational objectives. The purpose was to compile descriptions of those physical characteristics which could be employed in developing a conceptual configuration for a comparable EPA facility. Particular attention was addressed to the man/machine interfaces. The evaluation of the effectiveness of these facilities in meeting their design objectives was to provide guidance for the concept development. The estimated cost for constructing and implementing the facility is provided.

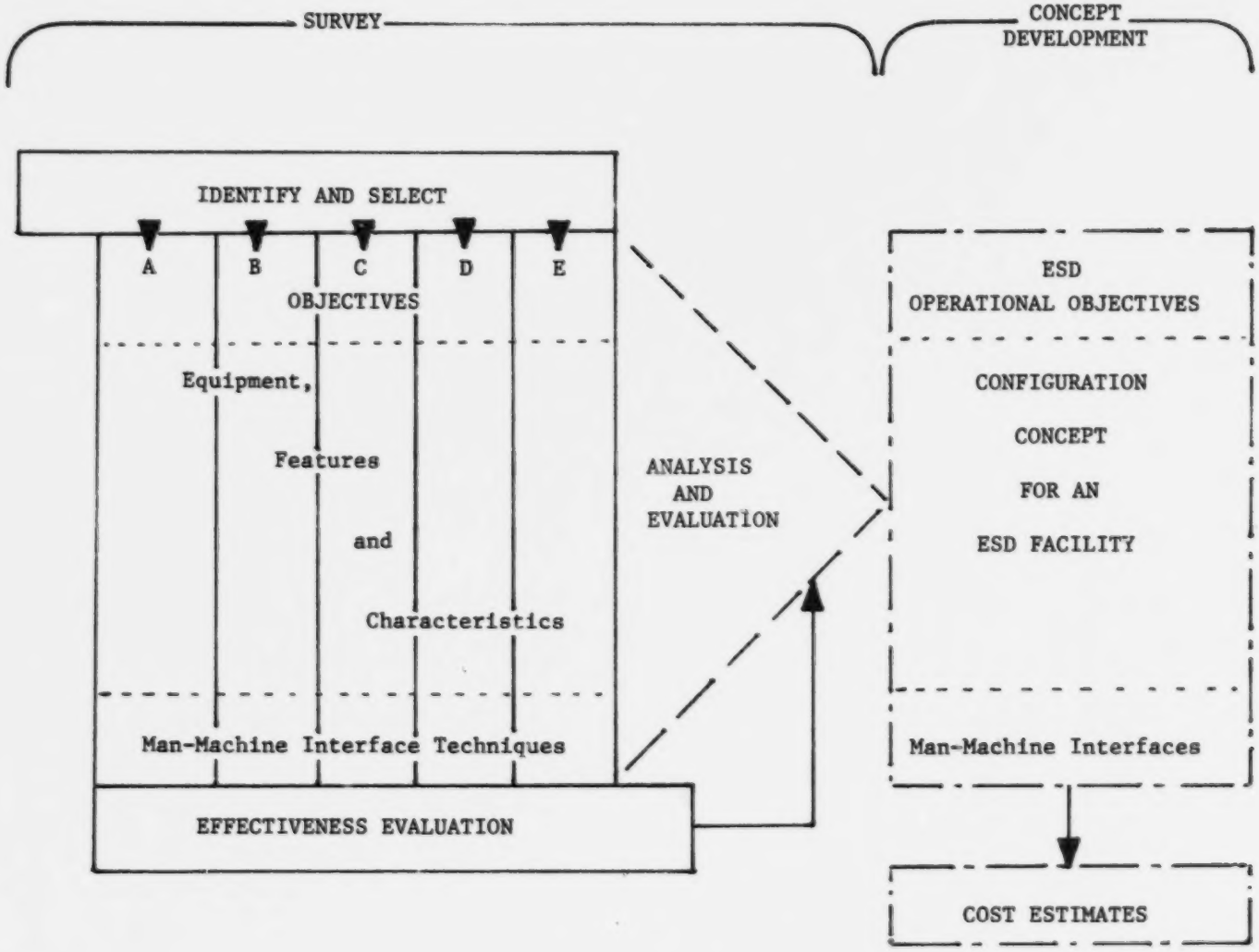


Figure 1. Scope of the Feasibility Study

3. Study Methodology

The study was conducted in a logical sequence of tasks which are depicted in Figure 2 and briefly summarized as follows:

a. Define EPA/ESD Operational Objectives. Define the mission of EPA and the scope of operations within ESD to establish a frame of reference for evaluating the appropriateness of candidate equipments, capabilities and techniques.

b. Generalize ESD Facility Requirements. Convert the above into a description of the capabilities which must be provided in the ESD facility.

c. Select Representative Sites for Survey. Identify facilities currently being used to support decision-making. Based upon the above determined capabilities, select representative sites for detailed examination and evaluation.

d. Survey Selected Sites and Technologies. Systematically examine the physical and design features of each site. Interview responsible operations personnel to obtain practical information regarding the capabilities, utilization and effectiveness of each facility. Examine the human engineering compatability and effectiveness of the man-machine interfaced technologies employed.

e. Analyze and Evaluate Survey Data. Correlate and analyze the above data in light of ESD facility requirements. Identify applicable features and capabilities and the methods and techniques used to implement them. Summarize findings and conclusions.

f. Develop Conceptual Configuration(s). Based upon the above analysis develop one or more conceptual configurations embodying the capabilities needed to support the ESD mission and responsibilities.

g. Prepare Preliminary Implementation Plan. Estimate a time frame for the development of the proposed configuration(s). Include required developments and appropriate milestones. Prepare recommendations accordingly.

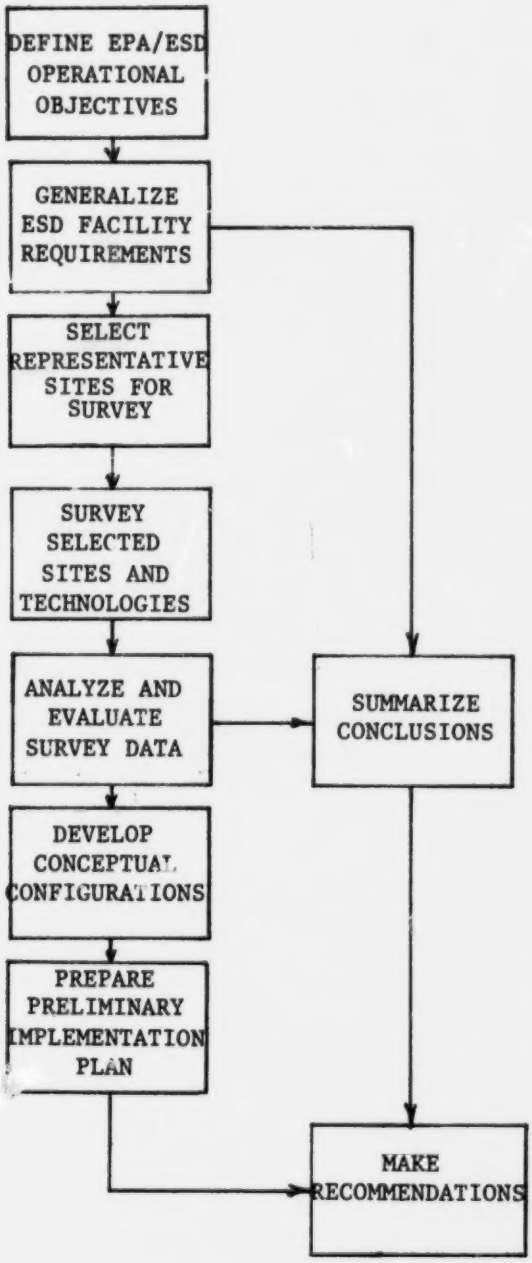


Figure 2. Study Methodology

B. BACKGROUND

1. Introduction

Historically, man has developed strategies to cope with the problems he has faced and has tested these strategies or solutions based on his knowledge of the problem. Based on the past performances of their enemies, military planners have created physical replicas of anticipated battlefields and developed plans to counter their enemies' strategies. Similarly, rulers have had their planners develop models of new cities and forts to meet the problems they anticipated, such as defense, food and water supplies, and accommodations for their people. As man and technology grew more sophisticated, the problems became more complex, requiring more complex solutions. By applying advanced technology, man can now accomplish exceedingly complex tasks that appeared insurmountable in the recent past. For example, men now journey to the moon, missiles are capable of achieving pinpoint accuracy on targets thousands of miles away, and businesses are able to accurately predict profit and loss for future years. Both the computer and information technology have played vital roles in these accomplishments. These technologies have been applied by the military and industry to assist in decision-making by predicting the consequences of decisions. Only the computer based technology can be applied to cope with these complex interrelationships with the speed and accuracy required to provide timely information. As applied to historic modeling concepts, these tools have truly become an extension of man's mind.

More recently, the "Urban Crisis" focused much attention on the problems facing national as well as local policy makers. It brought to the forefront our lack of knowledge about many of the cause and effect relationships

that exist in the day-to-day policy decisions made by both government and industry that are vital to society as a whole as well as the urban segments. As the concern regarding urban deterioration gained more depth, the scope became more broad as it extended to other vital segments of the environment. It appears logical that previously developed modeling theories and methodologies should be combined with advanced computer based technology and applied in the attempt to solve the problems associated with pollution of the environment.

2. The Role of the Environmental Protection Agency (EPA)

EPA is charged with the responsibility of protecting the environment. To date, this responsibility has been met by addressing the visable, obvious environmental problems that are present in our society. It is becoming increasingly more clear that dealing with the problems at hand will not be adequate to deal with the effects of future dynamic economic pressures, population, growth, and technological change on the environment. In addition to bringing available technology to bear in meeting the environmental problems that are with us now, environmental research is urgently required to foresee and predict the pollution problems to be dealt with in the future. The ability to cope with these problems and avoid continued degradation of environmental quality will be based upon the understanding and insight regarding their implications and the ability to provide solutions and alternative courses of action. Environmental pollution problems must be predicted and foreseen before they emerge as insurmountable in the long as well as the short term.

3. The Environmental Studies Division

The mission of the Environmental Studies Division (ESD) is focused on studies which investigate the total effect of environmental policy. In the

attempt to move EPA to this position of being able to provide for long term prevention of pollution and enhance environmental quality, the Environmental Studies Division of EPA is emphasizing the systematic development of capabilities in modeling and methodologies; comprehensive planning; and environmental management. While making these studies the members of the staff employ models as tools to access the impact of existing pollution forms regionally or nationally. ESD is constructing models to simulate the environmental, social, economic, and institutional systems that have traditionally guided urban and regional growth patterns. These models, together with others being surveyed, will assist in perceiving and managing those dynamic, interactive environmental controls. The use of advanced computer based technology to support research and analysis will provide a suitable setting for testing and refining all models which are to be developed or selected. On the one hand, these models are being refined to represent more and more closely the real processes interacting in the world, while on the other, public and industrial officials are being apprised of these developments by participating in simulations wherein they can see the overall effects of policy over a simulated passage of time. This is the first step to placing the Environmental Protection Agency in a position to anticipate and shape events rather than reacting to crises. Demonstrations of potential applications of modeling to interested policy makers will familiarize them with application of modern technology to environmental problems. To the extent that such technology is suitable for use within their jurisdications, this should stimulate recommendations for the use of applicable methods and procedures. Alternatively, in the event that the jurisdiction doesn't warrant or cannot justify supporting equipment for their development and application, the

possibility exists that federal facilities might be used for application to these regional problems.

The primary objective in supplying technical assistance on behalf of the Environmental Studies Division would be that policy makers and scientists gain appreciation of the effectiveness of this form of analysis and presentation which lend support so readily to evolutionary improvement. The technique is particularly effective for analysis of policy planning in environmental matters to validate policy concepts. Planning can be improved by projecting the ramifications of policy making over varying intervals of time so that precise measurements can be made of the interrelating elements and contingency plans developed. Inherent in this method is the capability to intermix with proper controls, the policy making actions open to policy makers so as to examine the impact of alternative options. Modeling could then apply heuristic techniques for representing the knowledge of situations according to the best current theories. Then, testing these representations against policy plans to determine how closely they correspond with real performance. Computer software offers immediate communications between users and the models which greatly improve the accuracy and speed in the development of these models.

After policy makers have been introduced to modeling through these presentations, the Environmental Protection Agency might undertake the collection of actual data within EPA's network of regions. Data base replicas of environmental, social, economic and institutional sectors could be reconstructed for those urban and regional areas to be subjected to intensive study through making use of the models definition of force elements as they would apply to transportation, industry, housing and utilities. At this stage, these

could be used for orientation in the situation where the policy makers understanding of pollution causes and effect can be directed to his immediate geographic jurisdiction. As the Regional Environmental Study Center becomes involved in the work of the Environmental Studies Division, the task of aiding state and local governments will move effectively towards decentralization.

The development of the General Environmental Model (GEM) represents advances in modeling techniques by providing the facility whereby all of these different elements can be represented. In this model, up to 11 different divisions of government enter into a policy making exercise. The effects of their policy is demonstrated by showing the impact of these policies upon the environment as a whole. The development of simulation models such as the River Basin Model have offered policy makers much insight into the interactions of society. the subtle expression of cause and effect relationships has had a profound impact on many of the policy makers who have participated in these simulation exercises. The shock factor of witnessing the consequences of a bad decision presents the policy maker with a lasting impression of the value of making well-informed decisions.

The enhancement of these tools and their application provide considerable promise and utility in meeting the complex tasks inherent to improvement of our environment. Through the use of simulation by policy makers from both private and public sectors, the impact of their decisions as they relate to the environment can be measured. Predictions on potential pollution levels could be used to reshape plans and redistribute industrial and commercial complexes. In planning the growth of the geographic regions, trade-off analysis will be improved through more extensive and accurate information

inputs and analyses. To support this modeling effort in the research phase and provide a smooth transition in operational capability development and application, new computer base analytical methods, procedures, and techniques must be developed to support the environmental analyst in performing environmental threat assessment.

4. Environmental Threat Assessment

The Environmental Protection Agency (EPA) is primarily responsible for providing pollution information inputs so that environmental threat assessments can be developed. This responsibility is shared to one degree or another by other federal agencies and the state and local governments. It is apparent that those functions leading to decision making regarding acceptable pollution levels and the actions taken to permit toleration, reduction, or elmination of pollution as a threat to the environment are the most critical to be performed. These tasks are inherent in environmental threat assessment. Due to the overriding importance of this task it should be considered in detail:

This function is beyond doubt the most critical of all functions to the long term survivability of the United States in situations that can lead to environmental destruction. There is little room for miscalculation and if the hard decisions regarding primary and alternative courses of action for environmental preservation are delayed too long, the current trend will become irreversable and the results will be disastrous.

There have been quality of life indications and warning regarding threats to the environment for many years. One of the major questions to be answered was: "What is the trend and what will be the results?" The decisions regarding counter measures have been delayed and the environmental protection agencies are now in a retaliatory posture. This question, then, has become: "What is pollution doing to the environment?" After elements of the environment have

been destroyed, the question then becomes "What has pollution done to the environment?" To answer the last question requires assessment of the damage to the environment and a review of the environmental status. The problem then becomes one of assessing the effects of pollution on the environment rather than environmental threat assessment, per se.

From the analytical viewpoint, environmental threat assessment is a continuum of assessments that begin with indications of pollution and trends regarding environmental deterioration. As the trend continues until unacceptable levels are reached and beyond, the objective becomes one of predicting, confirming, and establishing environmental pollution and deterioration patterns at any point in time. The purpose is to provide the decision makers with as much information as possible regarding the characteristics of pollution factors and trends and results in environmental deterioration. Such characteristics include, but are not limited to: origin; geographic areas; responsible persons, institutions, and polluting agents; the elements of the environment affected; the magnitude of the problem; and environmental pollution and deterioration patterns. On the basis of indications and warning of environmental deterioration, the characteristics of continuing patterns can be predicted to one degree or another. As more information is received and the patterns become more clear on the basis of factual results, the major problems include: correlation, cross-correlation, transfer, interpretation, and integration of information inputs; unaccepted time delays in processing and providing evaluated environmental data to the decision makers; gaining a decision; and implementation of countermeasures by responsible agencies. The need for research, development, and standardization of considerably better analytical aids to support the environmental analyst

becomes most apparent when crises conditions result from specific events such as major oil spills. During such periods, which result in major and lasting environmental damage, deficiencies in the environmental threat assessment system are bound to be reflected in the quality and timeliness of the decisions made. Such events must be evaluated rapidly in light of information that has been previously acquired and analyzed which bears on the situation. The degree of sophistication to which this function can be performed in support of environmental protection depends on:

- The quality and timeliness of indications of pollution and environmental deterioration;
- maintenance of an appropriate information data base;
- the rapid transfer of critical data within environmental protection systems;
- rapid, accurate analysis of the data flowing through the system by the responsible environmental analysts;
- a rapid dissemination of assessments at any point in time to the decision makers and agencies responsible for instituting counter measures.

The constraints established by the scope and complexity of the environmental assessment function cannot be met by the existing information system. The environmental analyst operates using manual collation methods and the exchange of information and analysis within the system requires too much time. As a result, the capabilities of the environmental analyst have become inundated by the massive volume of data within the system and more data is entering the system daily. The work generated by the sheer volume of data often results in major oversights regarding critical information inputs and unacceptable delays in providing evaluated data, assessments, solutions, and alternative courses of action to the decision makers.

5. System Capabilities

An automated information exchange and processing capability must be developed and implemented to support the environmental analyst at all operating levels. This system must improve the analysts' capability to exploit and disseminate event oriented environmental information, routine information, and evaluated environmental data. The analyst must be provided with access to all finished and unfinished historical and current pollution and environmental data pertinent to his problem area, regardless of its source or geographical location. A commonality of file structure must be implemented to enable automated collation of these data to expedite the preparation of the material for analysis. The analyst must be provided the capability to update the data base for which he is responsible and be assured that the information becomes available to other analysts within an optimum time period. Commonality regarding file structure must be comprehensive to the extent that collation of the data can occur in relation to subject matter, geographical area, and time of acquistion. Commonality and ready access must exist to provide exchange of information regardless of the effects of geographic separation. The analyst must be able to use and prescribe manipulation procedures in support of trends analysis and other statistical problems, and enter new data descriptions and correlation summaries for the benefit of other interested analysts. Automated procedures to immediately highlight incomplete data at the environmental analyst level must be implemented to enable the analyst to make his requirements known more rapidly to the environmental information collection sources.

In summary, a new approach to system development of analytical methodologies and automatic support systems is indicated. The developmental

approach must provide the system and the environmental analysts with the technology, methodologies, and procedures for:

- Cross correlation of data
- Development of alphanumeric data
- Inferential analysis
- Testing multiple hypotheses
- Developing environmental threat assessment routines
- Analysis of pollution threats and environmental deterioration
- Indications criteria modeling
- Analyst-to-analyst interaction and reaction in the environmental protection system
- Developing crises management modules
- Graphic output
- Large screen presentation of situation summaries
- Dissemination of evaluated environmental threat assessments in optimum time periods
- Development of standards for measuring pollution and environmental deterioration

6. System Requirements

On-line terminal support for the environmental analysts must be provided and be capable of stand-alone operations in maintaining appropriate files, in on-line storage and retrieval, and in supporting selected assessment functions of the local user. It must handle interrupt functions, call various process modules, and, in general, control the overall operation of the terminal hardware which will perform the basic information gathering. Priority interrupt handling also must be addressed in conjunction with on-line terminals.

The design should allow as much machine independence as possible to permit developmental implementation on an expanding system configuration for a variety of applications. Support modules must handle incoming/outgoing data transfer and on-line calls for each different interfacing device. Consideration must be given to the formatting structure, data control disciplines, error detection, buffering and data conversion requirements that are characteristic of the various systems from which data are acquired. Application software must support analyst tasks of querying and maintaining the data files.

Interaction with the disk files and modularity of design should be key factors. Three types of data exchanges must be facilitated:

- o Remote access-conversational exchanges are the existing local time sharing interactions in which discrete computations; inplace, immediate, small-program updates; small data-file updates; and low-volume data responses are performed. The development of an associative retrieval capability, and the use of inferential search to aid in accessing data files by type or areas of interest would also fall into this category.

- o Remote access-batch query/response exchanges include such large scale operations such as updating on-line data bases with a higher number of transactions, print-outs or on-line data files, retrieval of facsimile information for displays, and running of large or long-running programs.

- o Ultimately bulk data exchange for transmission of data between the facility and other systems on a routine, scheduled basis using batch bulk transfer programs will have to be considered. In such cases the need for demountable devices, such as magnetic tapes, would require prior coordination. In accordance with established policy, bulk data exchange through on-line systems would be held to a minimum.

The software subsystems must be made capable of reacting to various established priorities in data processing and the interleaving of such transactions by priorities. Data processing priorities must be incorporated in the software specifications to meet critical user requirements for environmental crisis warning and control data within established time limits. In addition, acceptable response times and the impact on data storage and processing priorities will have to be determined.

The operating procedures will vary according to the specific tasks being supported and the operating configuration will be modified from application to application; therefore, a very general operating system will be required.

7. Summary

In summary, the application of modeling theory and methodologies combined with advanced computer based technology to solve the problems

associated with pollution of the environment is a logical and sound approach. This does, however, introduce research and developmental problems with regard to computer based analytical methodologies and procedures for use by the analyst in performing environmental threat assessment. The computer based technology is within the state-of-the-art and can be applied to the analyst's problems associated with environmental model development. It will also provide a smooth transition from the research and developmental phase to operational implementation. The foregoing are major considerations in assessing the feasibility of the "Decision Room" concept.

C. GENERALIZED EPA FACILITY REQUIREMENTS

In general, a "decision room" is a facility that acts as a focal point for the following dynamic activities:

- o information flow
- o presentation
- o analysis
- o evaluation
- o assessment
- o communication
- o coordination and control
- o training

The scope of these activities vary significantly with the different purposes for which decision rooms are created. Accordingly, a 'decision room' is a tailored environment incorporating those dynamic activities that facilitate decision-making within the context of a predetermined set of problems. Decision-making, however, is not an activity of the "decision room" per se, but rather it is vested in and imported by the user; therefore, to call such a facility a 'decision room' is a misnomer which should be replaced by some term which more appropriately describes its true and unique functions within a given problem context.

The capability to perform the above activities for a given problem set is provided by a selected combination of equipments and techniques. The size and complexity of such a facility are determined by:

- o the operations to be supported and/or performed,
- o the types and quantities of information handled,
- o the levels of automated support to be provided,
- o the types and numbers of persons involved,
- o and the constraints imposed by time, funding, space and other limiting factors.

For the EPA problem environment, the kinds of operations that are required appear to focus upon the development and application of environmental models. Accordingly, the activities of such a facility will be research and analysis oriented and some of the principle capabilities to be provided will be:

- o Modeling
  - analysis and correlation
  - synthesis and evaluation
  - development and test
  - implementation
  - application
- o Information Handling
  - input processing
  - conversion
  - research and correlation
  - storage and retrieval
  - report generation
  - dissemination
- o Presentation
  - display techniques development
  - automated graphic display
  - display generation
- o Resources Development
  - Models
  - Data Base
  - Evaluations of Past Assessments
  - Environmental Research Library
  - Analysis Techniques

- o Computation
  - statistical
  - symbolic
  - geometric

D. FACILITY SURVEY

From a number of candidate facilities that support decision-making, a representative group was selected which most nearly approximated those capabilities most applicable to EPA operational objectives. The purpose was to develop a composite description of the physical characteristics which could be employed in developing a conceptual configuration for a comparable EPA facility. Particular attention was addressed to the man/machine interfaces. The evaluation of the effectiveness of these facilities in meeting design objectives applicable to EPA was used to provide guidance for the concept development.

In considering the survey, it is important to give recognition to some of the factors limiting its interpretation and evaluation. Mainly, these factors are grouped around the stipulation that the strength of the survey was not on the basis of direct comparability of facilities but rather on the supporting information gained. On this basis, it was not possible to develop an effective comparison of the facilities because:

- o The comparison depends heavily on the objective of the facility.
- o Facilities are built to meet specific objectives.
- o None of the objectives of facilities surveyed were identical to the EPA objective.

For facilities in use, comprehensive criteria information about why the facility was selected, its original objective and how it has changed, is not available. People operating these facilities always believe their facility

to be effective. Facilities unsuccessful in meeting their objectives disappear quickly.

The most useful information was gained from facilities in the planning stage. Particularly, in the observation of the effectiveness of facility capabilities applicable to EPA and in acquiring guidance information concerning mistakes to avoid in facility development. In these cases, the survey provided substantially valuable guidance.

1. Candidate Survey Facilities

The following candidate "Decision Room" or "Situation Room" facilities were considered for the survey in light of the EPA (and ESD) objectives and functions:

- Cities of New York, Chicago, and Los Angelos
- Defense Systems Management School, Washington, D.C.
- Domestic Security Center, Dade County Florida
- General Mills, Minneapolis, Minn.
- General Motors Institute, Detroit, Michigan.
- International Business Machine, Federal Systems Division, Washington, D.C.
- Mitre Corp., TICCIT System, McLean, Virginia.
- National Bureau of Standards, Washington, D.C.
- National Military Command Center, Pentagon, Washington, D.C.
- National Military Intelligence Center, Pentagon, Washington, D.C.
- Naval Supply Systems Command, Washington, D.C.
- Office of Special Projects, Naval Reserves, Washington, D.C.
- Office of Emergency Preparedness, Washington, D.C.
- Southern Railway, Atlanta, Georgia.

- o United Air Lines, Vice President of Operations, Denver, Col.
- o U.S. Dept. of Commerce, National Technical Information Service, Washington, D.C.
- o U.S. Department of Housing and Urban Development.
- o U.S. Dept. of Transportation, Washington, D.C.

2. Facilities Surveyed

The foregoing facilities were reviewed in light of the ESD requirements for:

- o A facility for developmental research.
- o A facility for the orientation of policy makers in the application of modern technology to our environmental problem.
- o A permanent repository of computer based models, research and technical information.
- o A distribution center to support the dissemination of research and technical information to state and local governments.

In addition to the foregoing criteria established to determine applicability of the objectives and functions of the candidate facilities, the problems associated with access to these facilities were a major consideration. For example, access was refused by the city of Los Angeles to their Emergency Control Center based on security considerations. Further, security considerations limited the surveys of the National Military Command Center and the National Military Intelligence Center. In these cases the material presented is governed by security considerations. Information gained though not presented, was used, however, to guide the formation of the composite description of the EPA facility in accordance with the purpose of the study.

In view of the foregoing considerations and the need for potential sources of equipment and technology, the facilities selected for survey had

one or more of the following functional objectives:

- o Control of emergencies and supporting analytical capability.
- o Control of corporate activities.
- o Management and control of governmental agencies.
- o Systematic storage retrieval.
- o Dissemination of information.
- o Intensive education.

The facilities surveyed together with a summary of the related descriptions follow:

a. Computer Caravan

The objective was to present state-of-the-art technology and equipment through display. In this interview, data was collected regarding a wide range of equipment and software for the man/machine interfaces of the facility. Notable among those gathered were capable, inexpensive microfiche viewers; processors, plotters and copiers; inexpensive non-graphic terminal devices; cassette recorders and minicomputers.

b. Defense Systems Management School

This is an educational display and monitoring facility for training project managers. This facility is housed in a 3 floor, small office building with a 70' x 50' x 20' auditorium, 6 classrooms (15 x 20), a monitoring room, a technical equipment and camera room and audio visual support facilities.

The auditorium has a large rear projection screen, video tape and closed circuit TV viewers and cameras. The seats are arranged in increasingly higher, circular rows. The auditorium can seat approximately

150 people. Each classroom has one computer teletype terminal, a center table, TV monitor camera and a television for closed circuit or video tape programming.

The operating concept of the facility is that the auditorium be used for initial, terminal and intermittent presentation appropriate to large group activities. The large groups are then broken into small groups which use the classrooms for intensive training purposes. The class activity is directed by the objective of the material presented which is supported by the television and computer terminal. The monitor camera within the room captures the activities of the room and transmits them to a monitoring room. If the material presented is not effective, this can be detected and the situation corrected. This practice improves the reliability of communication regarding material presented.

This facility presented interesting aspects of man/machine interface regarding use of terminal, television presentation and filming and auditorium techniques which were used in designing the facility proposed for EPA.

c. Domestic Security Center, Dade County, Florida.

This is a non-automated graphic display room designed to provide information to decision makers controlling the security forces at political conventions. The facility functions as an operations center featuring operational data, instructions, and other information flows. It is based solely on manual operation with no electronic data processing. The closed TV circuit from the beach area to the operation center was very useful during the recent political conventions. The displays reflected the police posture and activities as opposed to dissident groups and demonstrators'

locations and activities. The facility communications were primarily telephone and radio using police channels. The facility was also used to train the personnel who operated the center, for visiting police department representatives, and for public information releases.

d. U.S. Dept. of Housing and Urban Development

This is a non-automated display room for briefing government managers. This room is supported by a storage room and an audio-visual room. The room was established by a former participant in project control decision activities of NASA, space launch mission control. It is a fine example of how effectively information can be presented with a minimum of cost. A room, 22' x 22' x 8', painted with white magnetic paint, has a conference table and chairs, an easel, a carousel projector. The majority of presentations are done on the white walls using tape, waxed paper printed data which sticks to the wall. The data mostly involves the updating of pertinent statistics critical to operation of the agency. The form of the data is relatively fixed. This permits the simple method of updating to be used.

e. International Business Machines, Federal Services Division

This is a semi-automated display room facility for briefing corporate management. This room is supported by an audio visual preparation room and a projection room. The room itself is 23' x 40' x 9'. It has a central large rectangular conference table with chairs surrounding it and chairs around the periphery of the room. It seats up to 15 at the main table and up to 40 in the room. The focal points of the room are the front presentation screens and the podium to the left which controls the rear projection slide projector. There are two front screens, one driven by the projector and

the other uses a bay of 30 acrylic panels for display. Both of these screens are attended from the supporting rooms behind. The side wall, covered by a curtain, is a lighted acrylic panel with three tracks upon which can be mounted opaque displays, charts and photos prepared in the audio visual room. The audio visual room contains a fast poloroid photographic camera. Between the camera and the acrylic panels, by applying tape and press-type letters, presentation charts can be prepared very easily and quickly. This facility is being used heavily by IBM management and is notably effective for very reasonable costs.

f. Mitre Corporation, "TICCIT" System

This is a multi-media technological system for inexpensive data display. This system makes use of ordinary TV sets and touch-tone telephones coupled with cable TV lines to a minicomputer to permit interactive computation and display. The system uses video-tape, graphic disk storage, pattern generation techniques and direct film transmission.

Within the context of an information retrieval system, the minicomputer provides an impressive array of services potentially useful to EPA. The system is designed to support a programmed instruction program in college English and mathematics in two universities starting in the Fall of 1974.

g. National Military Command Center (NMCC)

This is a fully automated facility designed for the National Command Authorities (President, Cabinet, JCS, etc.) as a command and control center for the U.S. military forces operating through the World-wide Military Command and Control System (WWMCCS) during peacetime, cold war, limited war, and throughout the spectrum of general war operations. It is supported by

multi-media, secure communications, including voice communication. The computer facility providing support to the NMCC is the National Military Command Support Service Center (NMCSSC) using the Honeywell 6000 series computer.

This facility occupies the space of a large building of which over 80% of the space is devoted to supporting efforts. The supporting efforts incorporate the widest possible range of graphic presentation, communications, and computing equipment. Notable are the graphic terminals, the automated large rear projection screens and associated man/machine interfaces and human factor analysis.

The presentation area or decision room itself occupies a two story height and is in character like a large conference room with provision for overhead viewers. The room itself is surrounded by supporting facilities designed to support on-line briefing presentations. Everything within the room is designed conservatively to provide the minimum distraction. The lighting is indirect with variable control. The floor is not raised but is solid and carpeted to give a firm, quiet covering. Extra air conditioning is provided and circulated noiselessly with temperatures slightly less than normal to maintain a stimulating effect. No equipment except telephones and projection screens are visible to keep the atmosphere comfortable. The lighting, projection, sound, communication and other controls are managed by a technician. Sound is not amplified but reinforced to avoid a technical type environment.

This facility has a great deal to offer the EPA because it is a most comprehensive system. Although the character of the NMCC facility, unlike EPA, is shaped by the time constraints as well as the urgency of

its business, the complexity of the situations and the nature of the mission are comparable. The awareness of the criteria governing this facility have had a profound effect on the design work proposed in this study.

h. National Military Intelligence Center

This center is supported by the DOD Indications System. The objectives are to provide indications of hostile activities by foreign governments and warning of enemy attack. The center is supported by a wide array of secure multi-media communications to include secure voice. It is also supported by a complete, all-source, intelligence analytical capability. The data flows through the system from the intelligence collectors through data reduction, analysis and evaluation, and dissemination to the user. The available data on this facility are severely limited by security restrictions. The facility supports the facilities of the National Military Command System by providing evaluated intelligence inputs to the decision makers at the national level. This facility most nearly approximates the functions and capabilities that must be imbedded in a full scale, operational, environmental monitoring and control system.

i. U.S. Department of Commerce, National Technical Information Service

This is an automated information retrieval and distribution service for environmental and technical research information. The display devices are particularly applicable to the functions of environmental analysis. Of particular interest were the uses of interactive video terminals, computers, and microfilm. The facility provides technical reference service to governmental or private agents. Flexowriters, 1050's, or entry directly from the tapes are used. Keypunching is used for corrections only. This facility highlights the notable increase in information retrieval technology when it is realized that over 300,000 volumes of a library can be scanned in 5 to 10 minutes and microfilm copy selected of volumes required with same day service.

E. ANALYSIS AND EVALUATION

1. The Survey Results

The survey of the "decision or situation" rooms in operation was oriented on the objectives, physical characteristics, man/machine interfaces employed, and an evaluation of their effectiveness. A discussion of these considerations follows:

a. The objectives of the operational situation rooms surveyed were:

(1) Briefing rooms for presenting information related to management and operation of the organization. This type room had different characteristics for each specific purpose:

- o Business - characterized by functional orientation, effective but moderately economical.
- o Military - characterized by the urgency of its mission and the use of the most advanced techniques, effective, high pressure, great capabilities, costly to maintain and operate.
- o Government - characterized by extreme economy. It was effective but difficult to maintain.

(2) Control or monitoring of operation/security

These rooms were characterized by laboratory-like atmosphere with lots of visible equipment, but usually little or none of the equipment was directed toward display of managerial information.

(3) Systematic retrieval and dissemination of information.

These facilities were characterized by a library-like research orientation.

(4) Intensive education

These facilities are characterized by a class room type atmosphere.

Although helpful in defining the EPA facility, none of the foregoing facilities were exactly compatible with the EPA objectives.

b. The physical characteristics of the rooms surveyed are presented in detail in previous parts of this section. These characteristics varied greatly depending on the objectives and resources of each facility; however, certain general tendencies deserve discussion. With regard to non-technical characteristics, there seemed to be an agreement that the appearance of technical equipment has the effect of inhibiting achievement of the rooms objectives. Consequently, nearly all of the rooms had a carefully conceived character of simplicity and naturalness. This was achieved by concealing equipment, by 'reinforced' rather than amplified sound, by indirect lighting of uniformly controlled brightness, and overhead acoustic paneling and carpeting. Effective use was made in all facilities of wall space for display purposes, but in many cases curtains were used to conceal information that was not pertinent to the subject at hand.

c. Description of the man/machine interface technologies. Due to the advanced nature of the EPA facility only a few of these were directly relevant. The applicable interfaces included the interactive graphic terminal and associated computer software technology and the rear screen projection techniques used by the NMCC and the use of acrylic lighted panels and screen projection techniques of IBM and DSMS.

To amplify this point, a survey was made of equipment and technology which revealed important advances in the use of microfilm and microfiche, cassette driven terminals, and information retrieval technology.

d. The effectiveness of the facilities based on stated objectives. All of the facilities reviewed were evaluated as very effective based on the

statement of objectives. Considerations included the resources available, different characteristics, a different degree of relative effectiveness. A comparison of the highpoints of the evaluation are demonstrated in Figure 3, Comparison of Facilities Surveyed.

2. Summary of Equipment and Technologies

The developments in equipment and technology within the last 2 years have progressed so much that what was an apparent problem 2 years ago and which may have had only one solution (if it could be found), now has many solutions readily available. Generally, many equipment solutions are available, a number of which are very inexpensive; notably, microfilm and acrylic panel presentation. The one notable exception in the other direction is the use of computer, graphic terminals, and interactive software which are expensive yet remain among the required equipment of the facility because of the power, speed, convenience, and range of capabilities they offer. This combination of equipment offers such capability that the traditional form of computer listings is almost obsolete for many applications, particularly, for model-building, game playing and information retrieval which are the primary applications used by the facility.

In the area of computer software, interactive programs have reached the point where terminals of various types can be coupled to the same computer or to a network of computers, including minicomputers with the net gain being that more information is directly available and more computing and peripheral power available with a reduction in cost.

For a facility, such as the proposed Environmental Research and Analysis Facility, information can be: retrieved using a video terminal with

FACILITY	OBJECTIVE	EFFECTIVENESS-COST	PHYSICAL DESCRIPTION	MAN-MACHINE INTERFACES
NMCC	Military Briefing	o Comprehensively effective o Very Expensive	Dual facilities covering 1 full floor of large building. Room itself occupies 2 story height.	o Many graphic terminals o Fully automated roll projection. Large screens o Graphic support areas on-line o On-site computer
NMIC	Military Intelligence	o Comprehensively effective o Expensive	Dual facilities covering 1 full floor of large building.	o Panel Presentation o Semi-automated read projection slides o Audio-visual support
IBM-FSS	Business Management Briefing	o Very effective o Moderately expensive	3 room facility. Presentation room is 23 X 40 X 12.	o Acrylic panel presentation o Semi-automated rear projection slides o Audio-visual support
HUD	Government Management Briefing	o Very effective o Very inexpensive	2 room facility. Presentation room is 22 X 22 X 8.	o Entirely manual presentation o Context of material presented is relatively constant
DSMS	Military Training	o Very effective o Very expensive	3 story small office building. Auditorium 40 X 50 X 20. Classrooms 12 X 16 X 8.	o Large screen rear projection semi-automated o Extensive use of closed circuit television o Computer non graphic terminals
NTIS	Technical Information Retrieval	o Very effective o Inexpensive	2 story medium sized building. No presentation room.	o Extensive use of automated on-line retrieval system with computer terminals. o Microfilm technology
FLA	Domestic Security	o Effective o Inexpensive	1 large room. Command post facility, information, presentation, update, briefings, command communications.	o Manual graphic display o Communications gear o Television o Telephone
MITRE 'TICCIT' System	Interactive Information Retrieval	o Very effective o Very inexpensive	2 room facility. Computer room is 20 X 15 X 10. Presentation room 20 X 20 X 10.	o Multimedia interactive graphic display system o Video tape TV o Remote Filming o Touchtone telephone input

Figure 3. Comparison of Facilities Surveyed.

an information retrieval system and various data banks put on the screen of the terminal; modified and stored with other such data; and analyzed, tested, compared and processed into the best form of presentation. It can then be stored either in computer controlled memory or requested on computer output microfilm or remote hard copy printers. Once produced or microfilmed, the information can be copied, superimposed and made part of a rear projection presentation. Films of this kind can be easily arrayed into video tape. The film can also be copied onto cassette driven video terminals which have more limited options but are much cheaper. With a prudent mix of these equipments, the expensive equipment components can be used to the maximum of their capability and the installation can be ideal for model development and presentation preparation.

3. An Evaluation

In view of EPA objectives and requirements, the results of the survey of decision/situation rooms and facilities, and state-of-the-art technology, it is reasonable to conclude that the "decision" room concept is feasible. A concept of a feasible facility has been developed to meet the requirements and objectives of the Environmental Protection Agency and the Environmental Studies Division. These results influenced significantly the design of the proposed facility with regard to the follow considerations:

- An excessive display of technological equipment in a facility creates pressure and retards performance.
- A facility designed to be functional has a much better chance of becoming useful than one designed to be a technological showpiece.
- Before attempting to become fully automated, the models, software and presentation services of a facility should be developed.
- The importance of inexpensive, high-quality presentation media cannot be over-emphasized.

- The support and capability of the organization which administers the scheduling and operation of the facility is critical to its continued success.

- If all agencies which might be significantly affected by the facility are not contacted early in the project to clarify their relationships to the facility, costly delays and resistance to the project will result.

- Presence of sophisticated equipment in the facility tends to intimidate the users and retard progress.

- Upper-level management is generally reluctant to use facilities except for rare instances and special circumstances, unless they have been convinced of the urgency and utility of their presence, such as the military decision makers usage of their command and control facilities.

4. The Research and Analysis Facility Benefits

Such a research and analysis facility and the associated approaches to information management offers the optimum approach to providing effective support to the decision making processes regarding environmental protection policy and activities:

- It is capable of rapidly handling large quantities of data inexpensively.

- It will deal precisely with the quantitative data required to measure the state of the environment.

- It improves management policy statements.

- It improves interagency coordination.

- It should present the information regarding the state of the environment in ways which reveal to policy makers the overall consequences of their policy or practices governing the environment.

- Through mathematical modeling, it should facilitate precise identification of sectors of the economy by geography and ecology so that decisions can be made and effective action can be taken.

- It assists in processing the vast quantities of data available and eases the tasks of developing a consolidated picture of the environment.

- It should advance understanding of environmental phenomena by permitting effective development and presentation of models and providing an environment conducive to the study of the effects of these models.

- It should assist in increasing the realism in briefing governmental management.

- It should assist in preparing and disseminating information for training and indoctrination of managers in both government and private industry.

- It will improve the methodologies, procedures, and computer based equipment used by the environmental analyst.

SECTION IV

PROPOSED FACILITY

A. CONFIGURATION CONCEPTS

Having concluded that it is both feasible and desirable for EPA/ESD to have a facility for research and analysis, the next step is to conceptualize an appropriate configuration that will provide the required capabilities. In developing such a configuration certain priorities and other operational considerations must be addressed.

1. ESD Required Capabilities

The projected role for ESD in R&D support to EPA policy making, monitoring and assessment regarding environmental matters imposes the same burdens of timeliness, completeness, accuracy and credibility regarding its analysis as are imposed upon the military intelligence systems. Acceptable standards of performance can be achieved only through:

- Timely receipt of adequate, accurate and pertinent data
- The capability to rapidly process these data for analysis within the range of expected rates, volumes and formats
- The capability to rapidly select from an inventory of models that adequately cover the expected range of analyses required
- The capacity to rapidly correlate input data with selected models, and to derive and present the results for human assessment
- The capability to modify existing models and to develop new models to update the model inventory
- The capability to selectively store and retrieve historical events data
- The capability to select and control processing and computation in support of the above capabilities

- The capability to selectively compile and output the results of analysis in an appropriate human readable form

2. Time Considerations

The time frame for response within which these capabilities are systematically implemented for problem solution must be established. This is the first major dissimilarity with respect to comparable military intelligence systems in that the time frame for response is considerable longer (on the order of weeks or months rather than hours or days). Admittedly, exceptions will probably arise, but the system cannot hope to cope with a short response problem if it does not have a well established capability to handle steady-state operations.

3. Functional Integration

The above capabilities must be imbedded within a set of logically integrated components that can be selected to systematically perform their individual functions within the established time frames and data flow volumes. All of these functions need not be automated providing that they can be accomplished within the established time, rate and volume constraints, and are compatable with dynamic and format characteristics of the associated input and output functions. For most large volume data processing and computation operations, and rapid data storage and retrieval, however, the computer is the only logical choice for implementation.

4. Man/Machine Interfaces

For implementation in a research and analysis environment, special consideration must be given to the selection of those man/machine interfaces which will facilitate the monitoring and control of selected operations, and encourage an effective degree of interaction during research and analysis tasks.

5. Growth Capability

The hardware is available and the needed software can be developed to provide most of the required capabilities cited earlier. Such a configuration would constitute the basic capability which would provide a foundation for growth in various important ways.

a. The capability to modify and develop models will be enabled by providing for the formulation and testing of hypotheses through simulation using real data. This will constitute a capability for expanding the model repertory and maintaining its currency. The increasing variety of analyses which can then be performed will result in more of the input data being used in analysis and an increase in the reporting of the analyses to a larger community of users. It will also establish the basis for providing a feedback to data collection to improve the kinds and quality of data collected, and to tailor its pre-processing to meet the more specific input requirements of the new and improved models.

b. The capability to selectively store and retrieve historical events data will constitute the system memory and the basis for developing analytical experience. The organized compilation of these evidential data are prerequisite to the development and perception of new relationships and trends from which hypotheses are formulated and new models developed. Equally important is that significantly large samplings of correlated data provide standards for the evaluation of new data, the credibility of which improves as new data are compiled. In the matter of monitoring the environment and establishing controls, implementing the principle is handicapped by the absence of 'benchmark' data upon which to base such standards. Consequently,

it becomes necessary to theoretically calculate the quality of clean air from data representing the current trends in pollution in much the same way that archeological finds are dated by Carbon 14 analysis.

c. Another capability for growth derives out of the improving capability for analysis and reporting. A research and analysis facility can remain relatively isolated until it begins to generate products that are of practical value to a growing community of users. At some point in time it will be compelled to support an implementation in an operational environment to apply the evolved capabilities. Accordingly, improved requirements and specifications will have to be developed to improve the quality and pertinence of data collection and preprocessing; production scheduling and control of routine analyses may have to be instituted; appropriate mechanisms for the reproduction and dissemination of product reports may have to be initiated; and the facility may find that it is required to provide direct support to management regarding environmental matters. These possible relationships are simplistically illustrated in Figure 4, System Functional Relationships.

d. Finally, if the facility is required to fulfill such a role as envisioned in c above, it must have the capability for expanding its equipment and software resources to keep pace with its expanding requirements and activities. The following paragraphs describe a baseline developmental configuration which provides this capability for expansion. The discussion concludes with an architectural concept of the analytical working environment of the expanded system when it reaches its full capacity for analysis and support.

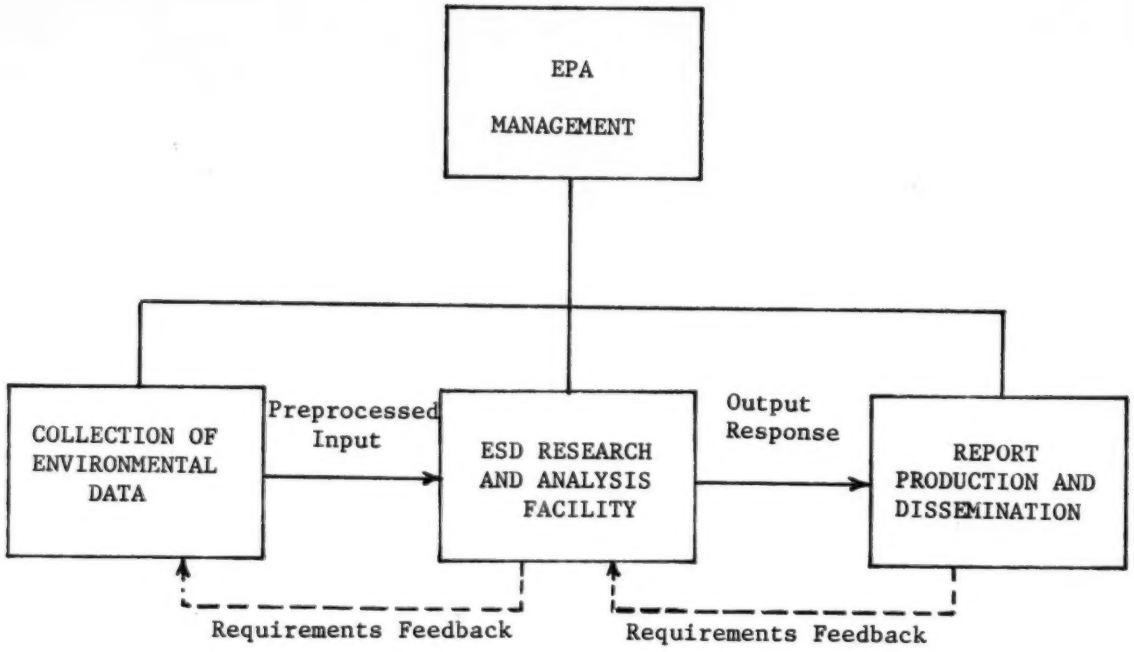


Figure 4. System Functional Relationships.

B. DEVELOPMENTAL CONFIGURATION

1. Purpose

A developmental configuration, as a first step in implementation, is the means for consolidating and further developing current analytical processes and techniques to a more experienced functioning level. The initial cost investment will be minimal. The objective is to demonstrate the validity of a centralized capability and to build a following of satisfied and dependent subscribers to the offered products and/or services. For ESD, such a computer-supported research and analysis facility would serve as a resource which would greatly benefit the development of environmental models and could assist in the training, management, library, audio-visual and information functions of the EPA.

2. Facility Location

Based upon the configuration design and equipment selection, a specific site in the metropolitan Washington, D.C. area will be selected. Candidate sites will be surveyed to determine their comparative suitability and the modifications required to house the facility. Concurrently, the design specifications will be completed to include: details regarding the design and testing of terminal work stations; the power requirements for the equipment; and the integration of equipment and facilities to maximize the effectiveness of operations. Site recommendations will be presented to EPA which will include the preparation costs for each site.

Both the developmental and the projected configurations have been designed to fit in any standard Washington office building which conforms to the standard ceiling height, heating, flooring and air conditioning. The

initial space requirement is 44' X 66' and will accommodate to the 20' square bay pillar layout which is standard for these buildings. Initially, both the computer and the terminal facilities can be accommodated in this area. When expanded to the full projected capability, the facility may require additional floor space for the computer equipment.

3. Configuration Description

The definition of what constitutes a "minimum configuration" depends upon whether it will be co-located with and supported by the current 360 computer computer system, or whether it is to operate independently as a "stand-alone" capability. A minimum hardware configuration employing the 360 "HOST" concept is depicted in Figure 5 . In this configuration, all analytical functions and processes would be initiated and controlled via the analyst terminal in an interactive on-line mode and all processing would be performed within the HOST computer. To the analyst, this system would appear to operate as a dedicated resource. The basic software required to implement this capability is available and can be economically implemented.

A minimum hardware configuration for "stand-alone" operations is depicted in Figure 6 . Independent operation imposes a requirement for an increased central processor capability; one or more mass data input devices; and a significantly greater mass storage capacity. The software required to implement this capability is likewise available. The latter configuration has the greater capability to accommodate incremental enhancements as they are needed because it is unencumbered by a dependency upon a host computer system. This is not to say, however, that it should not be connected to the HOST system in the future as a means of significantly increasing its capability.

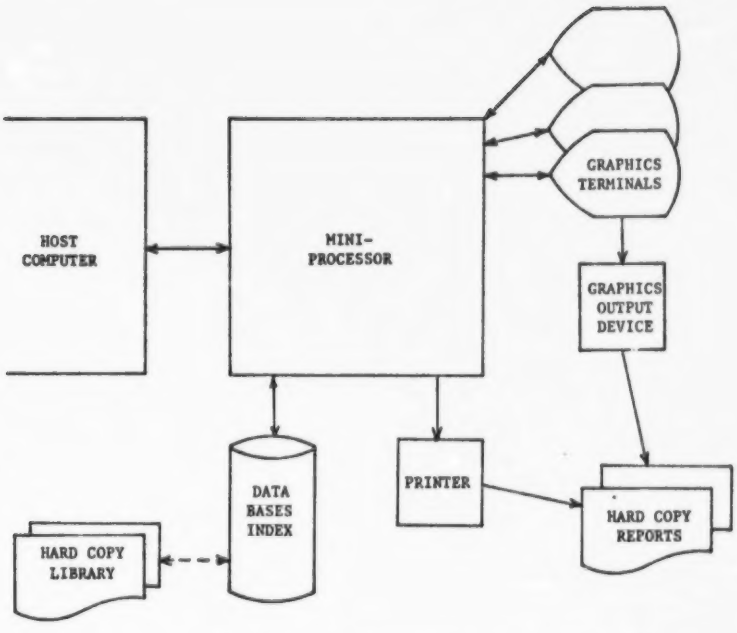


Figure 5. 'Dependent' Developmental Configuration.

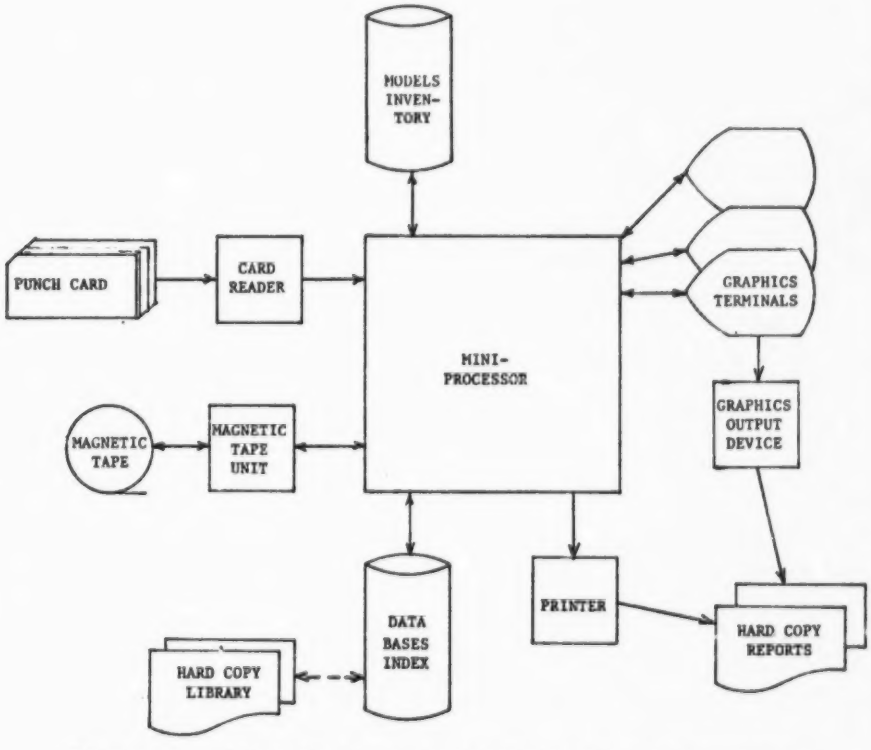


Figure 6. 'Stand-alone' Developmental Configuration.

The distinction, here, is that the first configuration is "dependent" upon the host mainframe, whereas, the "stand-alone" configuration can employ host computer support when and if needed.

4. Benefits

The primary objective of this facility is to provide effective housing for the development of computer-based environmental models, for the use and presentation of these models for training, and for determining more effectively and precisely that which is required to make policy and decisions relating to environment information. Such a facility will be considered effectively managed if it is determined that it has contributed to the more rapid development of beneficial environmental research and models, and if the using of these environmental models has resulted in the formation and execution of policy which effect economies that more than offset the cost of the facility. Clearly, by providing computer support to research and analysis, EPA will accelerate research support to all levels of government and will thus initiate a most promising line of beneficial results related to improving environmental management.

In addition to the primary objective, the facility will provide:

- An atmosphere conducive to advanced planning and research.
- A capability for substantially improving the amount, quality and response time of information resources in response to EPA management inquiry.
- A permanent central repository for computer-based models, research and technical information.
- A central directory of environmental agencies at state and local levels.
- Information resource to support the communication of research and technical information between EPA and other governmental agencies at Federal, State and local levels. (In this role, the facility

can improve coordination between EPA and these agencies through its increased capability. Further, it can rapidly process and disseminate the increasing quantity of information both produced and required by other agencies.)

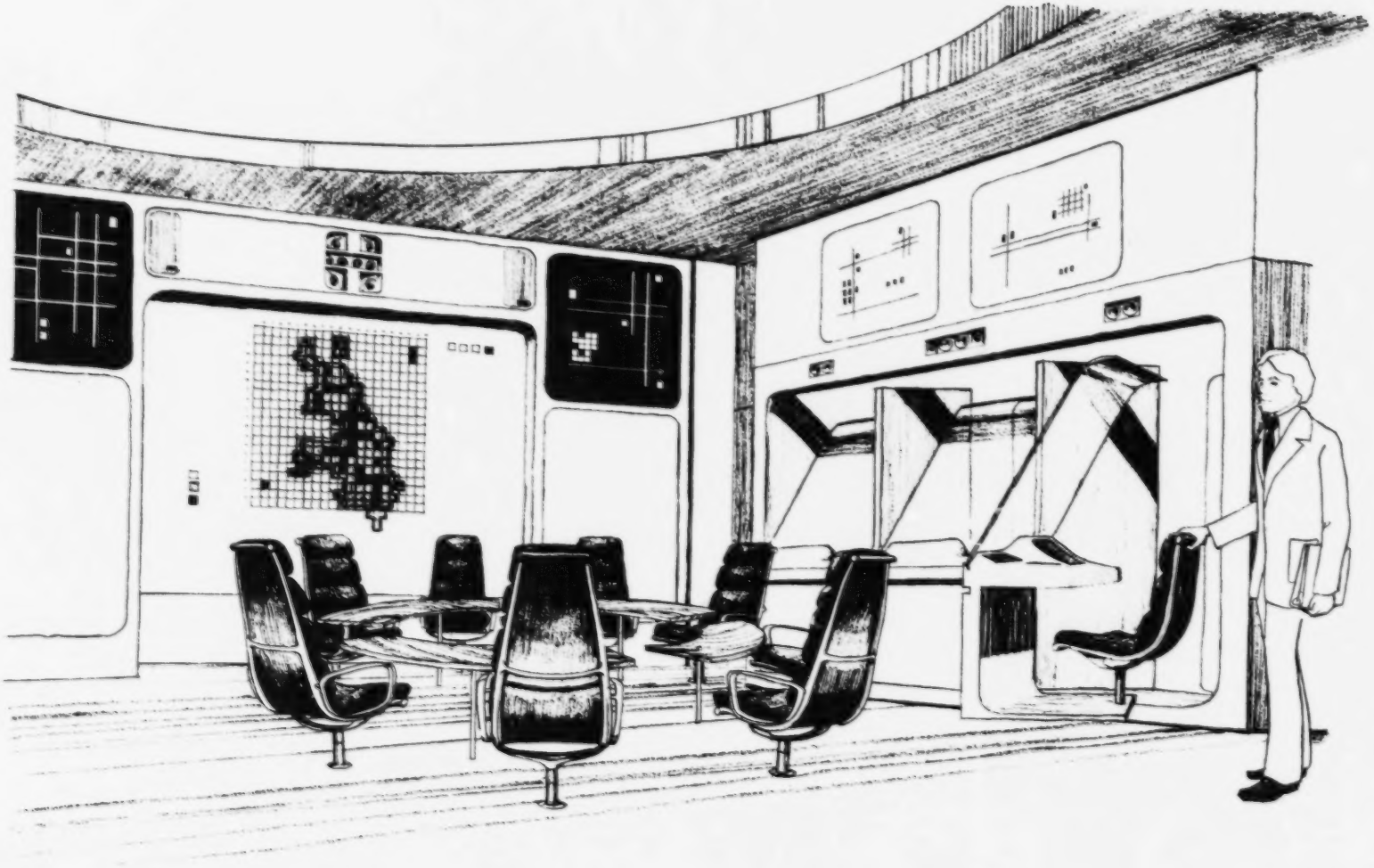
- o The capability to support improved coordination within EPA of the following:
  - Management
  - Data Processing
  - Library
  - Information
  - Research
  - Audio-visual
  - Training
- o A resource where films related to measurement, monitoring and control of environmental processes can be presented to brief management upon the status and effectiveness of control programs.
- o Demonstration of the state of technology applications to assist state and local authorities to visualize how such capabilities could be beneficially employed and supported within their own jurisdictions.

C. PROJECTED ARCHITECTURAL CONCEPT

1. Dual Purpose

In the long view, the proposed environmental research and analysis facility is primarily oriented to developmental work with the dual capability to provide for formal presentation and training. (Figure 7 presents an artistic concept of the room.) The facility is designed to meet the requirements for both analysis and development of models and for the preparation of presentations. As more experience is gained in developing presentations and the demand for them increase, the facility is designed to provide its reconfiguration to accommodate the change in orientation.

A consequent feature of the design based upon this dual orientation is that equipments are selected to support both presentation and product development; therefore, any equipment not in use for the presentation can be



COMPUTER GRAPHIC FACILITY

made available for developmental work. In this way, the utilization of equipment resources would be optimized.

2. Facility Component Areas

Nine component areas comprise the facility: (Refer to Figures 8, 9 and 10 Plans Computer Graphic Facility

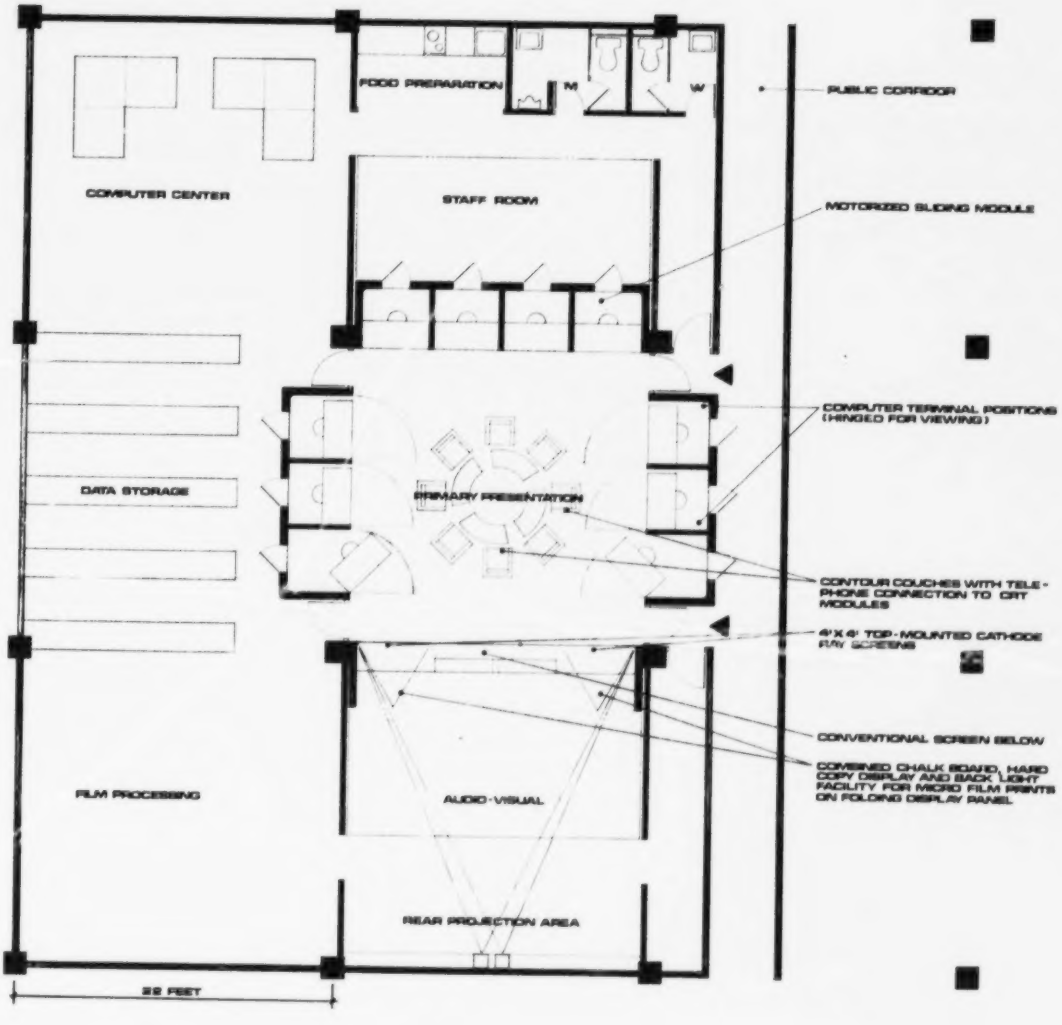
1. Computer terminal positions or work stations
2. Primary presentation
3. Rear projection area
4. Film processing
5. Data storage
6. Computer center
7. Staff room
8. Food preparation
9. Rest rooms (adjacent food preparation area)

3. Facility Description

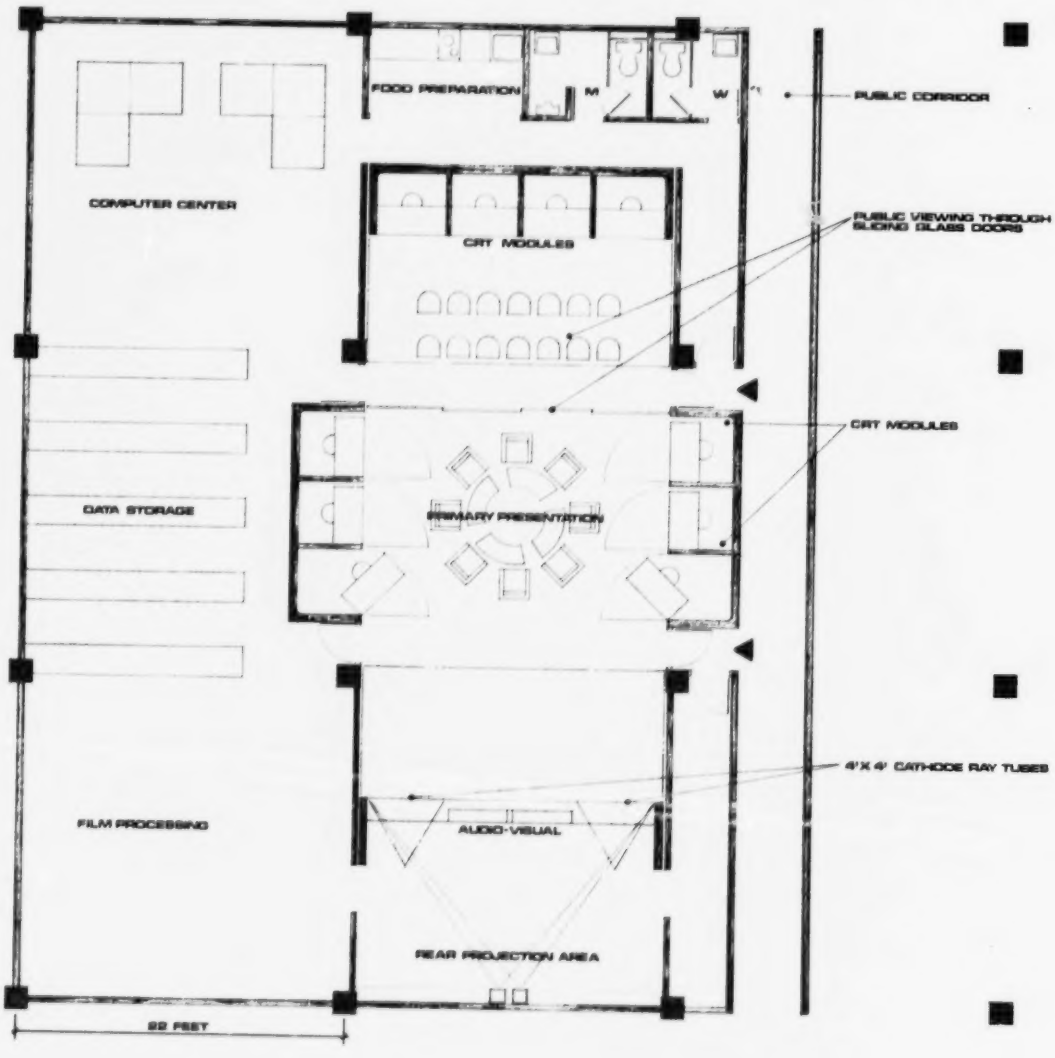
a. Terminal Work Stations

The main feature of the facility is the terminal work stations. These individualized stations will permit optimum use of equipment while serving the dual purposes of developmental work and presentations. In the presentation mode, no more stations than are actually needed are used and the others remain free for other developmental or preparatory work. Each station located at the sides can be swung outward to face the main screen. In the enclosed position, each station is isolated and sound proofed to enable individual work to be conducted. At the option of the room monitor, who controls the operation of the room, any terminal position can be included in

AXONOMETRIC PLAN
COMPUTER GRAPHIC FACILITY



PLAN - CLOSED POSITION
COMPUTER GRAPHIC FACILITY



PLAN - OPEN POSITION
COMPUTER GRAPHIC FACILITY

or excluded from the proceedings of a group presentation. Groups of stations can also be interconnected to conduct group communications aside from the main presentation. When fully equipped, each station will have a desk containing a computer-driven or microfilm video terminal, keyboard input, space for computer listings and paper work, sound system and control buttons, and writing space. The interior will include a fold-down shelf for a portable calculation, or microfilm viewer.

b. Primary Presentation Area

The primary presentation area is envisioned as having sliding walls which will permit expansion to handle presentation of from 8 primary conference participants and 10 terminal operators to larger presentations of up to 32 persons including viewers. In the closed position, the extra space behind the rear wall would provide space for a staff room (see Figure 9). In the open position, sliding acoustic glass doors would be closed to isolate viewers from the proceedings (see Figure 10 In either situation, the terminal work stations could be positioned so that each station would face the large screen. When in the closed position, any terminal stations not involved in the presentation would be entered through a back door. In this way, independent developmental work could be carried on, thereby maximizing the use of equipment.

Images on the large screen at the front of the primary presentation area (see Figure 7), would be projected from the rear from a projection room. The black screens at either side of the top front would be large cathode ray video screens, computer-connected to the terminals so that when a development of common interest has been reached on one terminal, it could be projected instantaneously on the front screens for group viewing. Once captured, the

picture could also be requested at a terminal for computer microfilm output which would permit its storage for later projection on the large screen. The large screen would have two projectors so that overlays could be created. In this way the pollution of air, water or solid waste could be superimposed upon the same base map. When a notable overlay position was developed, it could be filmed by the overhead cameras and used for subsequent presentations by rear projection slides. As a practical matter, technology has reached a point where this type of copying can be done in a very few minutes with little effort or cost. This would be one way of using the room to prepare presentations or, in conference, to capture high points for summary reporting and subsequent conferences. This type of operation illustrates the evolutionary or developmental nature of the facility in that new work being developed could be used almost immediately.

c. Auxiliary Presentation

The white side screens in the front of the room at either side of the large projection screen and below the black video screen are visualized as a bay of 30 screens held in parallel housing beside and behind the facility. One screen would be a chalkboard and another a corkboard for mounting different types of displays. The other 28 displays boards would be a translucent acrylic material. As each panel was pulled to the closed position a switch would be closed, back lighting and projecting high quality static images for visual presentation. These screens could be replaced and mounted so that any number of panels could be introduced for presentation. This acrylic panel form of presentation provides for very inexpensive images of high quality and effective presentation impact and is being used in many of the facilities surveyed.

Overhead cameras have the facility for photographing any of the visual images presented and also overhead projection devices could be used to project to the top of the terminal stations as shown in Figure 2. In addition, an overhead camera could film, simultaneously, the ongoing presentation and the reactions of the participants. Subsequently, analyses could be made of the presentations and observations drawn as to the effectiveness of presentation and changes to be made on the basis of these studies. In the event that large number of fixed video figures are required for one presentation where day-to-day continuity is required, video records of the proceedings could be displayed on the sliding glass door which would ordinarily be closed to isolate viewers from the presentation in the open position of the room (Figure 5). In this use, the sliding doors would be drawn and backlighted while using the acrylic panel presentation supported by racks or hooks on the door.

d. Other Support Areas

The rear projection area would be maintained in semi-darkness. The two projectors shown in the rear of the projection area would be loaded in carousel form for presentation. These cameras would be controlled either from behind by the supporting team, or from the first terminal by appropriate controls.

The film processing area is where presentations would be prepared. Space would be provided for additional terminals to be used in presentation preparation. Primarily, however, the equipments would be audio-visual type equipment, cameras, chart-making materials, tables for mounting the acrylic panels, and microfilm retrieval devices. The data storage area would provide for retention of microfilm and other presentation aids. Microfilm cartridge retrieval terminals and other presentation aids would be

included. In addition to data storage, the area will service the various terminals being used in developmental work. The computer center could be used to house the minicomputer and supporting peripheral equipment connected to a remote, but larger computer facility. This area could be used for additional terminal equipment on a testing or auxiliary basis. The staff room would be used as a lounge or for staff work when the presentation area is in use. The food preparation area would be provided since the center is designed for use at all-hours, anytime. Rest room facilities are also required.

4. Equipment and Technology Recommendations

Under equipment and technological recommendations two primary aspects of operation must be considered. They are: the room in full operation; and the room as it is initially equipped. One of the primary beneficial features of the design of the Environmental Research and Analysis Facility is that it would begin initially with a relatively small equipment inventory for the purpose of developing the models. In this instance, it is envisioned that the facility might include only one video graphic terminal supported by other equipment that was not as expensive, that would create images for simulating modeling conditions. Other supporting equipment might include another video screen upon which the materials can be graphed and presented for simulating the behavior of graphic terminals on non-graphic terminals which otherwise access only the alphanumeric portions of the computer data banks. The non-graphic terminal could be used for analysis in correlation with graphic information. The large screen slide projectors are not unreasonably expensive and would add to simulating such model presentations. In the fully developed facility, however, it is visualized that all the terminals would be graphic

terminals. They would be interconnected through the computer or a controller so that environmental models could be simultaneously displayed for group analysis; hence, the terminals could work independently or interactively. In an interactive or cooperative mode, one terminal could work on the chemical properties of pollutants while another concentrates on the socio-economic factors, both addressing the same time period and geographical area. Each terminal would have the capability for requesting computer output microfilm which, subsequently, could be fed into the film processing room, produced for slide projection and organized for later presentation. Each of the working stations would have a microfilm reader to combine the advantages of condensed microfilm storage. Hence, the facility is visualized as providing a true multi-media working environment. The primary advantages of microfilming are the high density and low cost for storage and retention of materials. It is viewed as a particularly desirable resource for a facility of this type. Other types of equipment also should be considered. Video tape systems are now becoming relatively inexpensive and could contribute greatly through their rate control and stop-action capabilities. The basic developmental configuration features the minicomputer for the on-line development of models which can service one application without the costs involved by tying up the main computer for multiple access. Incremental enhancements of this configuration could encompass the internetting of several minicomputers, as well as, the ability to connect to a larger HOST computer for major model development and processing support. Under this mode of operation the minicomputers would manage the communications of the terminals and provide the terminal interfaces required. Audio recording capabilities for this facility should be provided. New equipments are now available for sequencing the agenda of meetings and

polling of opinions. This equipment is currently being used in assisting legislative bodies to proceed through the agenda of their meetings.

5. Summary of Recommended Equipment and Man/Machine Interfaces

Connection to HOST computer

Graphic video terminals

Control device(s)

Minicomputer(s)

Large projector screen

Rear projector(s)

High quality polaroid camera(s)

Microfilm viewer(s)

Alphanumeric CRT terminals

Microfiche viewer(s)

Microfilm cassette recording terminal

Video tape record/player

Microfilm copier

Xerox copier

Chart making accessories

Acrylic panels

D. ESTIMATES OF THE COST OF IMPLEMENTATION

Based upon the construction of the standard Washington office building, site preparation costs will range from 15 to 25 dollars per square foot. Thus, the total cost of preparing a facility area of 44' X 66' would range from $50,000 to $80,000 dollars for the fully completed facility. Naturally, the more functional developmental configuration would require proportionately less

preparation than would the completed facility as previously described.

The lowest cost estimate for basic implementation of a HOST supported developmental configuration is 22K dollars. This cost would be evenly divided for the hardware and software required.

The cost of the "stand-alone" developmental configuration is estimated at 250K to 300K depending, primarily, upon the size of the mass memory storage to be provided. In this case, hardware costs alone will range from 150K to 200K with software requiring the remainder.

The above estimates do not include, the cost for the development of application software for developing models and for support to analytical functions. These costs must be estimated for the specific applications as they are required.

Obviously, facility costs can accumulate and, uncontrolled, reach unacceptable levels. Through purposeful planning and modular design and development, however, it should be possible to implement the full range of required research, analysis, developmental and presentation capabilities in the envisioned facility for under 1000K dollars over a 2 to 4 year period. This time frame precludes "crash" programs and any attempts to implement special analytical capabilities in advance of providing an effective and reliable basic operating system. Furthermore, it is anticipated that by directing the efforts of computer system design and implementation, professionals to creating effective tools for research, the ESD analysts can contribute significantly to the actual development of the facility; analytical capability and effect overall cost savings in the applications area. The amount to be spent for the facility will depend to some extent on the strategy selected by EPA as to which configuration they elect to build. Upon the determination of

EPA's preferences, an appropriate bid for design and implementation will be prepared. Our recommendation favors a 'stand-alone' developmental configuration as the most versatile and potentially expandible approach. Furthermore, because this should not be delayed, this configuration presents the greatest potential for application to current problems and providing the basis for meeting those anticipated in the future.

Datametrics is prepared to provide a detailed plan for the design and implementation of the facility in accordance with EPA plans and preferences. It has the experience and capability to manage and control all aspects of site preparation; equipment selection, installation and testing; software development; communications; and systems integration. Arthur Cotton Moore Associates will provide Datametric the architectural drawings and specifications required for facility construction.

The conclusions based on SECTIONS III and IV of this study and the recommendations regarding continuation of the project are presented in SECTION I and II.